T-12: Introducing new batch of parts

Statistics group

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Statistics Group

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Summary

Latest batch of parts:
Cyl.Liner/TopRing/Rodbearing/MainBearing/PistonCrown[W/ Y/ Z/ Q/ F **randomized subgroups excluding subgroup A**]

- Option 1: do nothing. There are only three data points and, in general, the current ICF is doing a reasonable job => **recommended option**
- Option 2: apply updated ICFs* for liner wear
- Option 3: apply updated ICFs* for Oil consumption
- Option 4: apply updated ICFs* for liner wear and Oil consumption

*additive or multiplicative

- as more data is gathered, another update can be done

Summary table

		Before and After ICF applied by parameter							
Predicted/ Target					additive ICF		multiplicative ICF		
ALW	ln ALW	Lab	original ALW	ln ALW	afterCF	Original scale after CF		afterCF	Original scale after CF	Current ICF 09/2021 multiplicative
Predicted	3.5086	G	39.5	3.6763	2.9523	19.1	0.794	2.9190	18.5	0.7610
TARGET	2.7850	D	33.1	3.4995	2.7755	16.0		2.7786	16.1	
additive ICF	-0.7240	A	26.7	3.2847	2.5607	12.9		2.6081	13.6	
OILCON	ln OILCON	Lab	original OILCON	ln OILCON	afterCF	Original scale after CF		afterCF	Original scale after CF	0.907
Predicted	4.4061	G	94	4.5433	4.2303	68.7	0.929	4.2207	68.1	
TARGET	4.0930	D	72.2	4.2794	3.9664	52.8		3.9756	53.3	
additive ICF	-0.3130	A	86.1	4.4555	4.1425	63.0		4.1392	62.8	
ATRWL	Keep current ICF as is									0.846
PB	Keep current ICF as is									
PB2	Keep current ICF as is									

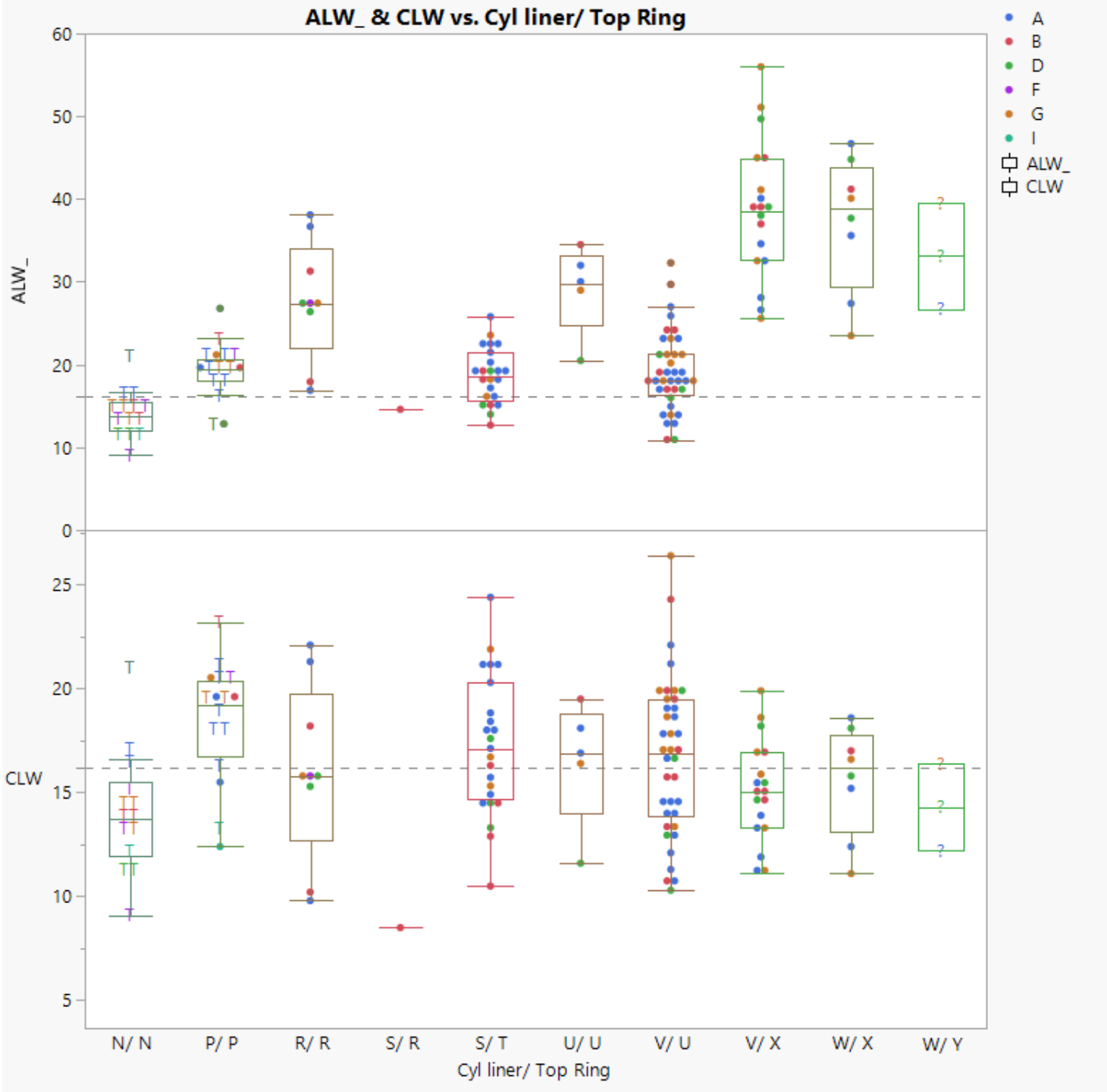
Liner Wear

Before ICF

W/Y/Z/Q seems similar to V/X/Y/P/D forward

there are only 3 tests… and they overlap with N/N parts from target tests, back in 2005 (all N/N and most P/P were part of the target)

After current multiplicative ICF = 0.761



The updated ICFs are

ICF = 0.724 (additive)

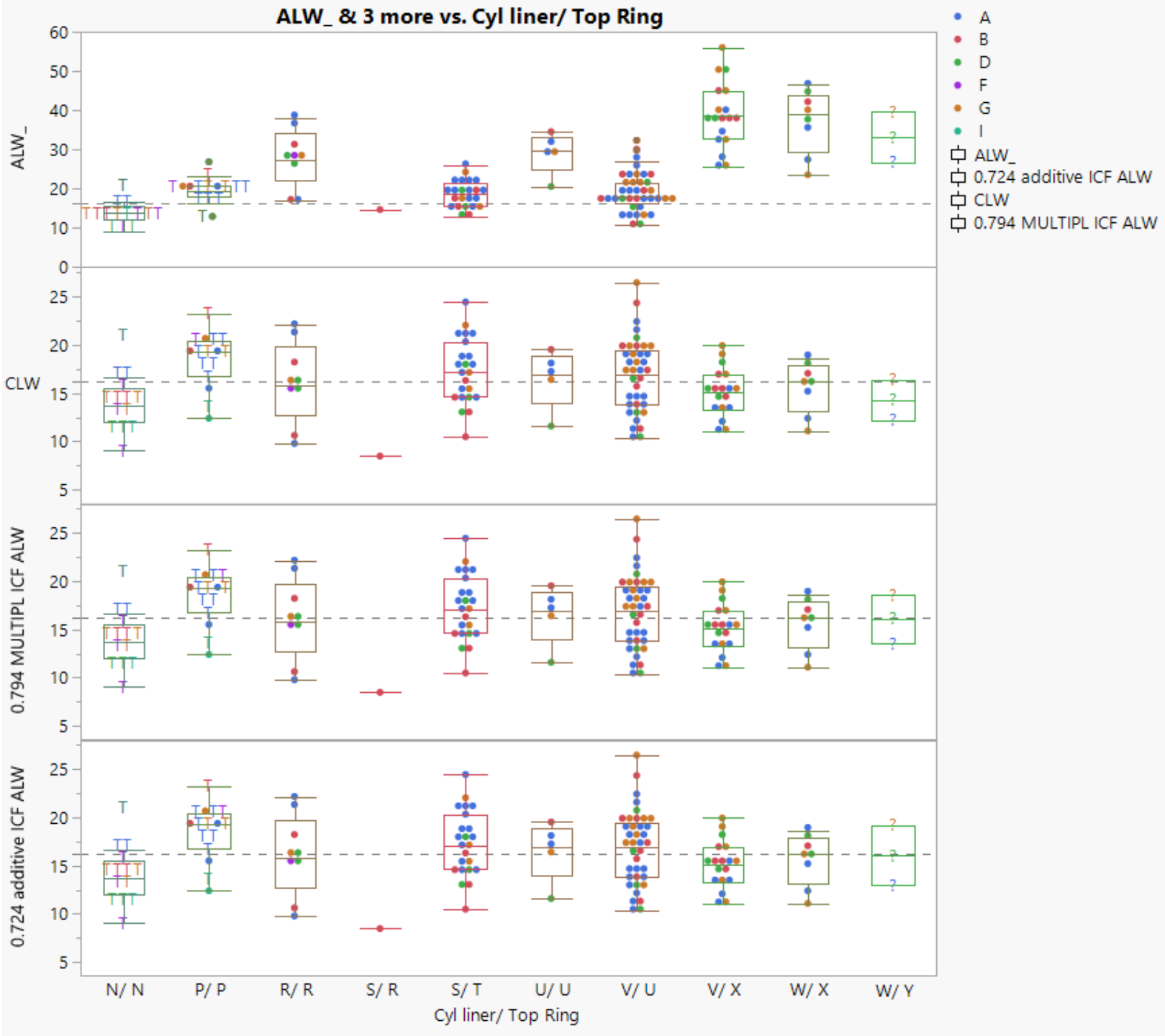
ICF =0.794 (multiplicative)

Before ICF

After current ICF = 0.761

After applying updated ICF
Multiplicative ICF =0.794
to W/Y parts

After applying updated ICF
Additive ICF = 0.724
to W/Y parts



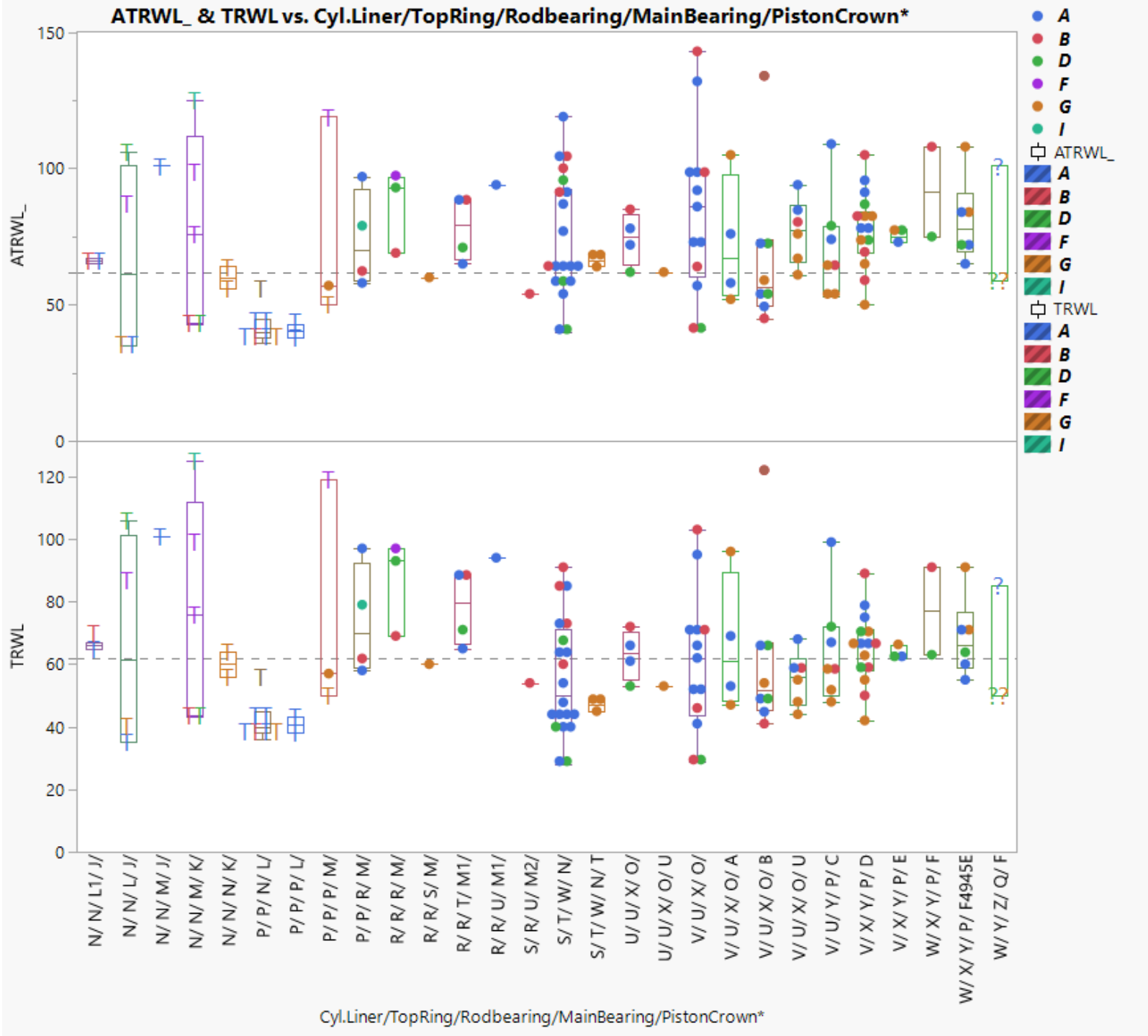
LN ALW	n=135							
Expanded Estimates								
Nominal factors expanded to all levels							TARGET	multipl ICF
						3.5086295	2.7850112	0.794
Term	Estimate	Std Er	t Rati	Prob>|t|				
Intercept	3.102492	0	71	<.0001	1		additive ICF	
IND 2[PC10E/ 821]	-0.05985	0.1	-0.4	0.6614	1		0.724	
IND 2[821-1]	0.062011	0.1	0.8	0.4261	0			
IND 2[821-2]	0.097775	0.1	1.3	0.1919	0			
IND 2[821-3]	-0.02174	0.1	-0.2	0.8232	0			
IND 2[821-4]	-0.0782	0.1	-0.8	0.425	0			
LTMSLAB[A]	0.0757	0	1.8	0.073	0.25			
LTMSLAB[B]	0.072792	0	1.5	0.1468	0.25			
LTMSLAB[D]	-0.00539	0.1	-0.1	0.9222	0.25			
LTMSLAB[F]	-0.00255	0.1	-0	0.9777	0			
LTMSLAB[G]	0.106776	0	2.2	0.0268	0.25			
LTMSLAB[I]	-0.24733	0.1	-2.2	0.032	0			
Cyl liner/ Top Ring[N/ N]	-0.45397	0.2	-2.9	0.004	0			
Cyl liner/ Top Ring[P/ P]	-0.16255	0.1	-1.2	0.2313	0			
Cyl liner/ Top Ring[R/ R]	0.068866	0.1	0.6	0.5369	0			
Cyl liner/ Top Ring[S/ R]	-0.55627	0.2	-2.6	0.0122	0			
Cyl liner/ Top Ring[S/ T]	-0.34196	0.1	-4	0.0001	0			
Cyl liner/ Top Ring[U/ U]	0.211912	0.1	1.6	0.1087	0			
Cyl liner/ Top Ring[V/ U]	-0.21052	0.1	-2.5	0.016	0			
Cyl liner/ Top Ring[V/ X]	0.537432	0.1	5.3	<.0001	0			
Cyl liner/ Top Ring[W/ X]	0.503543	0.1	4.4	<.0001	0			
Cyl liner/ Top Ring[W/ Y]	0.403515	0.1	2.8	0.0066	1			

Top Ring Weight Loss

Before ICF

At this time, there is no need for updating the ICF

After Current ICF=0.846

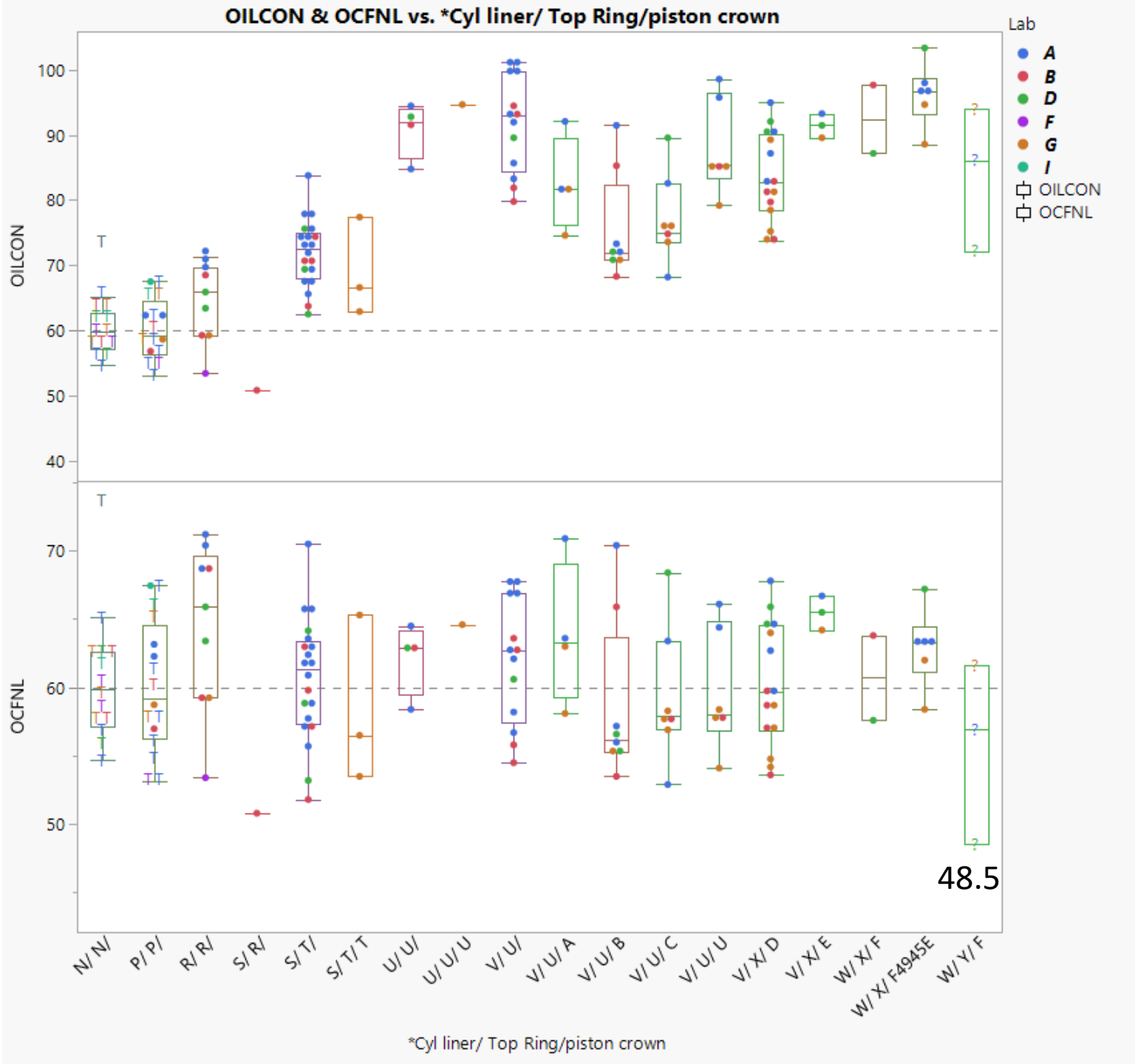


Oil Consumption

Before ICF

One test is lower than the other two results

After Current ICF = 0.907



The updated ICFs are

ICF = 0.313 (additive)

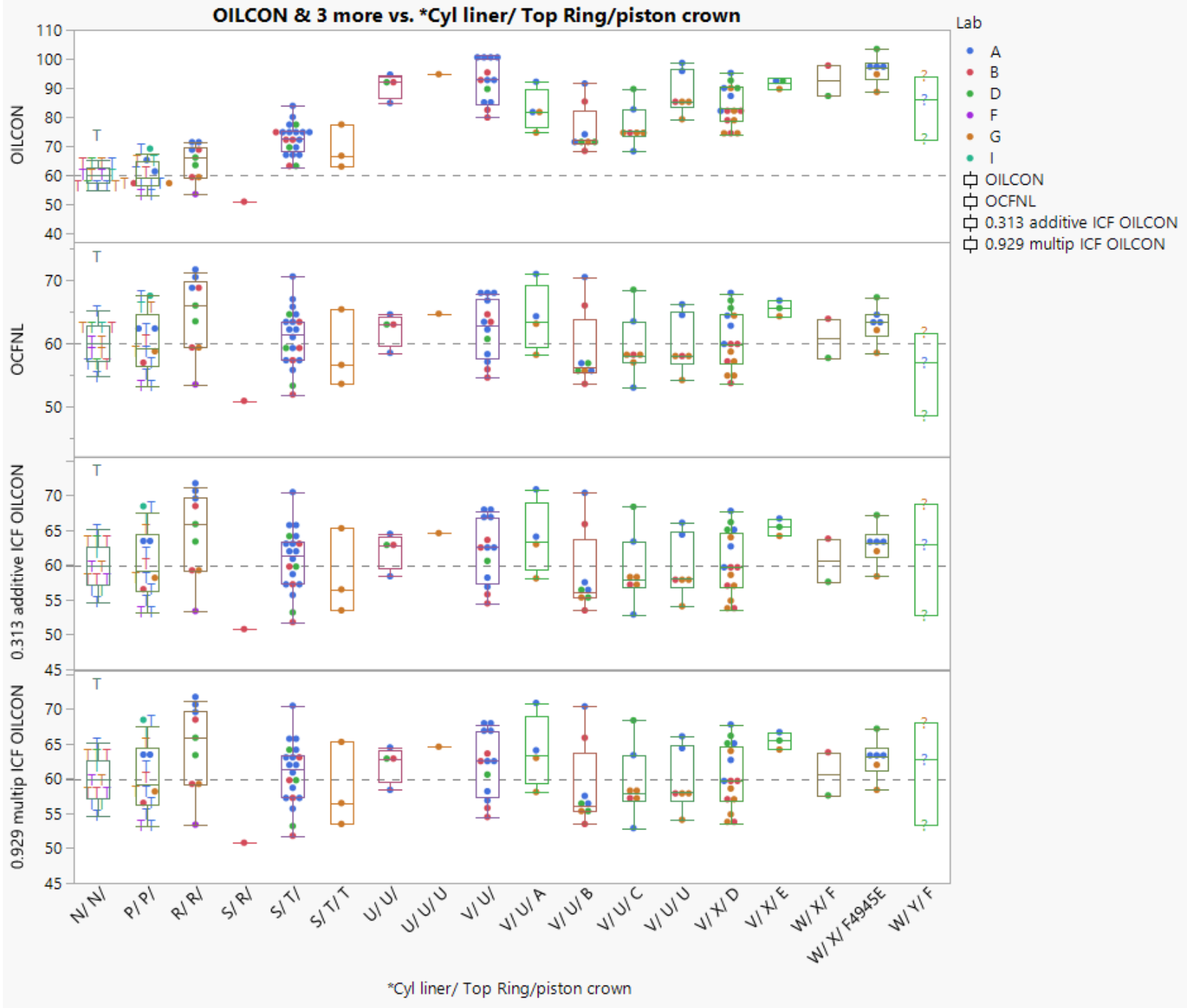
ICF =0.929 (multiplicative)

Before ICF

After Current ICF = 0.907

After applying updated ICF
additive ICF = 0.313
to W/Y/F parts

After applying updated ICF
multiplicative ICF =0.929
to W/Y/F parts



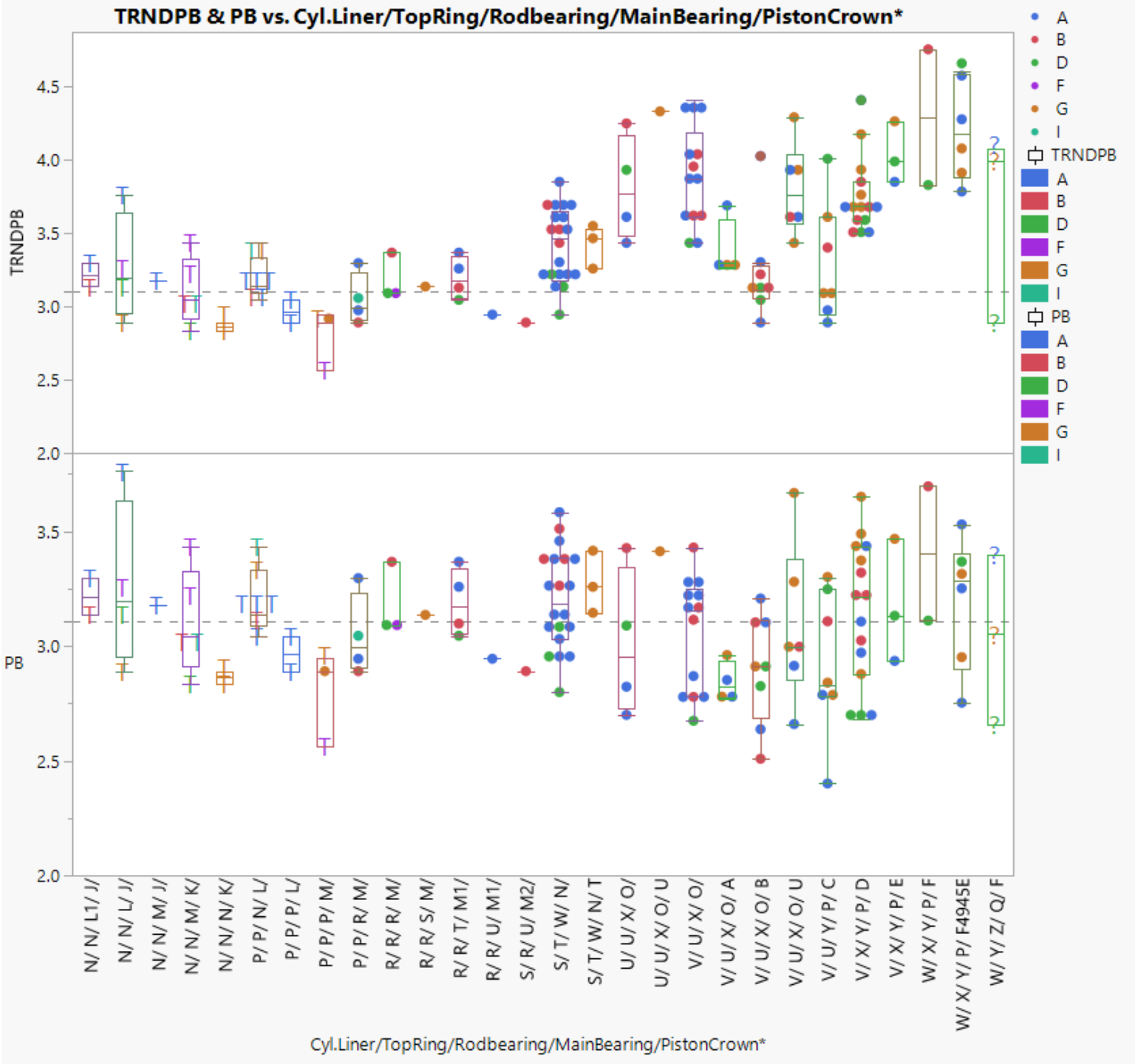
OILCON								
Expanded Estimates								
Nominal factors expanded to all levels								
							TARGET	multipl ICF
Term	Estimate	Std Er	t Rati	Prob>|t|		4.4061122	4.093	0.929
Intercept	4.366335	0	209	<.0001	1			
IND 2[PC10E/ 821]	-0.01522	0	-0.3	0.7585	1		additive ICF	
IND 2[821-1]	0.015656	0	0.6	0.5841	0		0.313	
IND 2[821-2]	0.021244	0	0.8	0.4408	0			
IND 2[821-3]	-0.02111	0	-0.6	0.5638	0			
IND 2[821-4]	-0.00058	0	-0	0.9886	0			
LTMSLAB[A]	0.022083	0	1.4	0.1529	0.25			
LTMSLAB[B]	-0.02967	0	-1.6	0.1135	0.25			
LTMSLAB[D]	-0.00735	0	-0.4	0.7173	0.25			
LTMSLAB[F]	-0.03232	0	-1	0.326	0			
LTMSLAB[G]	-0.03982	0	-2.1	0.0353	0.25			
LTMSLAB[I]	0.087089	0	2.1	0.0362	0			
*Cyl liner/ Top Ring/piston crown[N/ N/]	-0.23907	0.1	-3.7	0.0004	0			
*Cyl liner/ Top Ring/piston crown[P/ P/]	-0.27417	0.1	-4.7	<.0001	0			
*Cyl liner/ Top Ring/piston crown[R/ R/]	-0.2111	0	-4.4	<.0001	0			
*Cyl liner/ Top Ring/piston crown[S/ R/]	-0.42442	0.1	-4.9	<.0001	0			
*Cyl liner/ Top Ring/piston crown[S/ T/]	-0.11681	0	-3	0.0036	0			
*Cyl liner/ Top Ring/piston crown[S/ T/ T]	-0.11615	0.1	-2	0.0434	0			
*Cyl liner/ Top Ring/piston crown[U/ U/]	0.160829	0	3.2	0.0016	0			
*Cyl liner/ Top Ring/piston crown[U/ U/ U]	0.245309	0.1	3	0.0036	0			
*Cyl liner/ Top Ring/piston crown[V/ U/]	0.160718	0	5	<.0001	0			
*Cyl liner/ Top Ring/piston crown[V/ U/ A]	0.053386	0	1.2	0.2514	0			
*Cyl liner/ Top Ring/piston crown[V/ U/ B]	-0.03833	0	-1.1	0.2872	0			
*Cyl liner/ Top Ring/piston crown[V/ U/ C]	-0.01006	0	-0.3	0.7973	0			
*Cyl liner/ Top Ring/piston crown[V/ U/ U]	0.128239	0	3.6	0.0004	0			
*Cyl liner/ Top Ring/piston crown[V/ X/ D]	0.072899	0	2.2	0.029	0			
*Cyl liner/ Top Ring/piston crown[V/ X/ E]	0.158444	0.1	3.1	0.0025	0			
*Cyl liner/ Top Ring/piston crown[W/ X/ F]	0.177807	0.1	3	0.0039	0			
*Cyl liner/ Top Ring/piston crown[W/ X/ F494	0.20379	0	5	<.0001	0			
*Cyl liner/ Top Ring/piston crown[W/ Y/ F]	0.068687	0.1	1.3	0.1828	1			

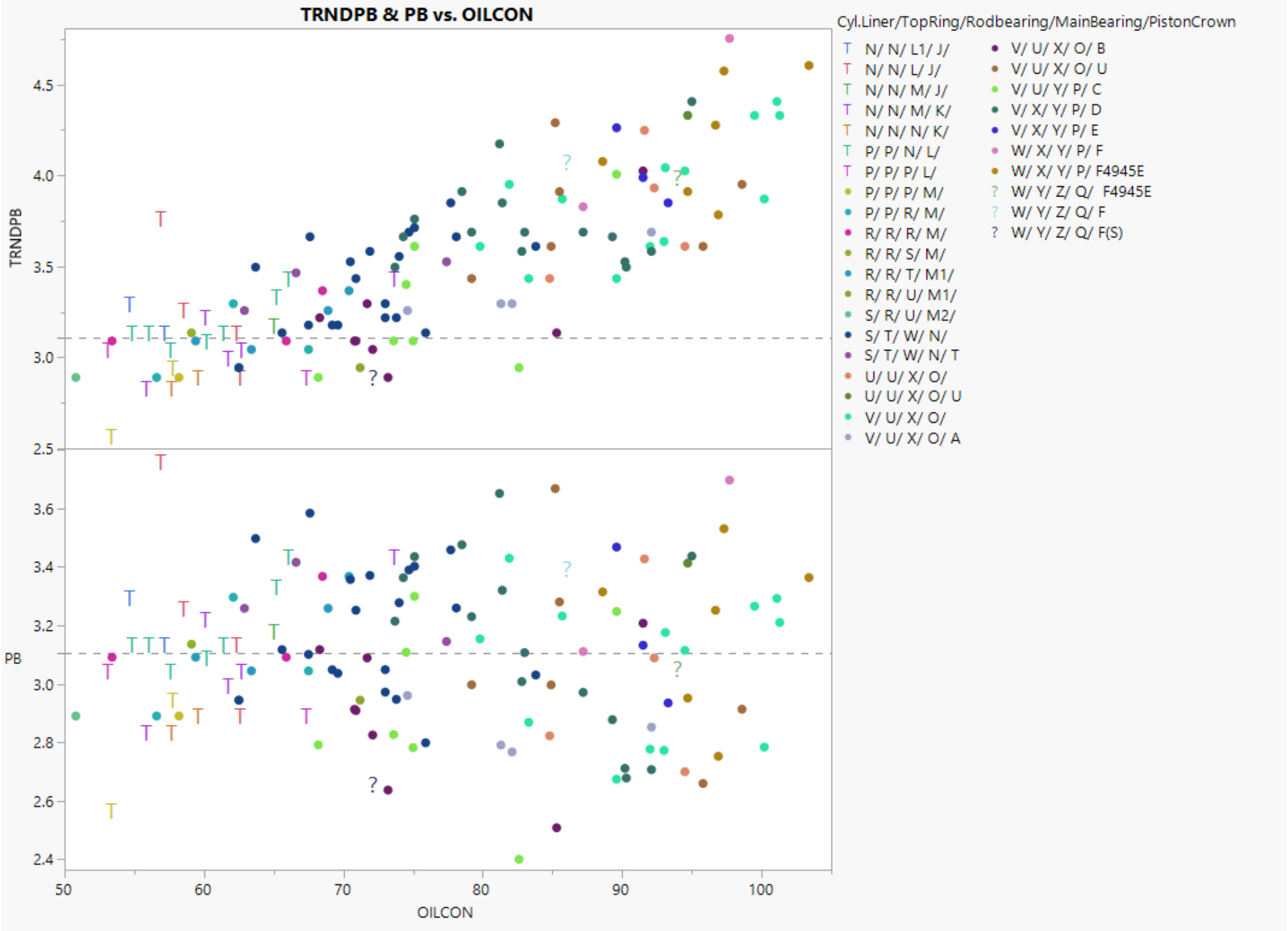
Pb Oil Consumption Correction

Before ICF

After Current ICF

At this time, there is no need to propose new correction




TRNDPB & PB vs. OILCON
TRNDPB
PB
OILCON
4.5
4.0
3.5
3.0
2.5
3.6
3.4
3.2
3.0
2.8
2.6
2.4
50
60
70
80
90
100
Cyl.Liner/TopRing/Rodbearing/MainBearing/PistonCrown
N/ N/ L1/ J/
N/ N/ L/ J/
N/ N/ M/ J/
N/ N/ M/ K/
N/ N/ N/ K/
P/ P/ N/ L/
P/ P/ P/ L/
P/ P/ P/ M/
P/ P/ R/ M/
R/ R/ R/ M/
R/ R/ S/ M/
R/ R/ T/ M1/
R/ R/ U/ M1/
S/ R/ U/ M2/
S/ T/ W/ N/
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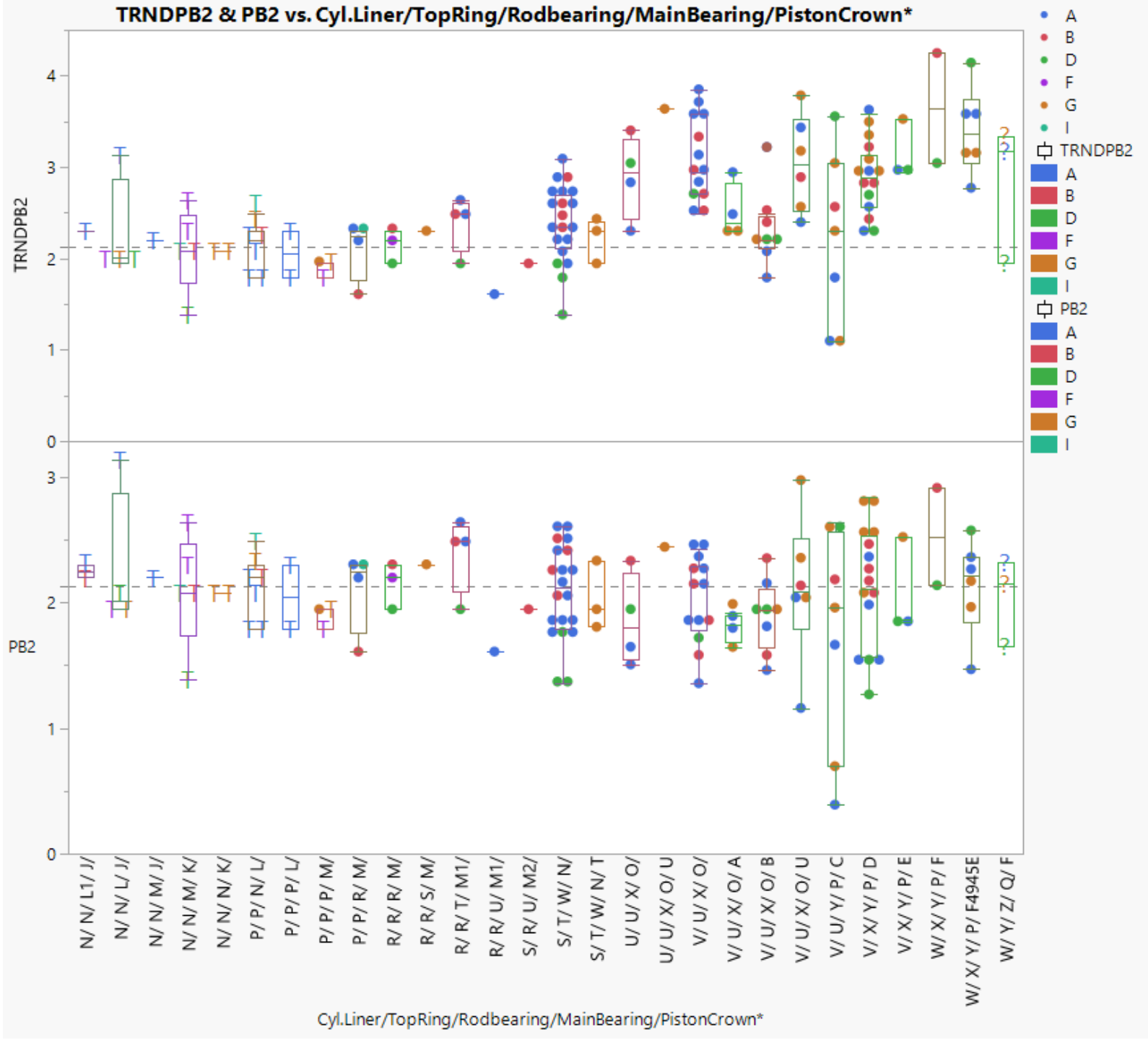
V/ U/ X/ O/
V/ U/ X/ O/ A
V/ U/ X/ O/ B
V/ U/ X/ O/ U
V/ U/ Y/ P/ C
V/ X/ Y/ P/ D
V/ X/ Y/ P/ E
W/ X/ Y/ P/ F
W/ X/ Y/ P/ F4945E
W/ Y/ Z/ Q/ F4945E
W/ Y/ Z/ Q/ F
W/ Y/ Z/ Q/ F(S)

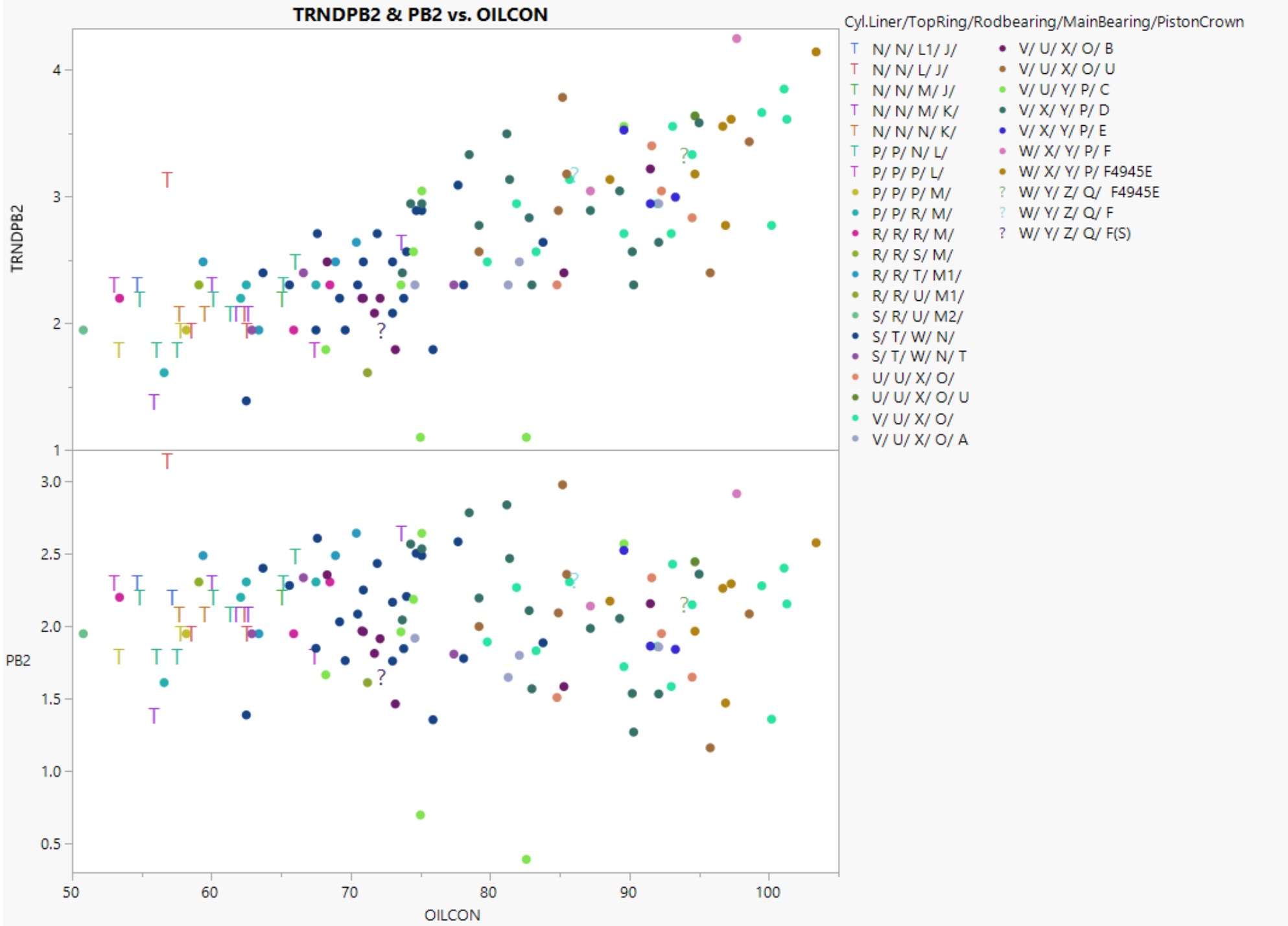
Pb2 Oil Consumption Correction

Before ICF

At this time, there is no need to propose new correction

After Current ICF




TRNDPB2 & PB2 vs. OILCON
TRNDPB2
PB2
OILCON
4
3
2
1
3.0
2.5
2.0
1.5
1.0
0.5
50
60
70
80
90
100
Cyl.Liner/TopRing/Rodbearing/MainBearing/PistonCrown
N/ N/ L1/ J/
N/ N/ L/ J/
N/ N/ M/ J/
N/ N/ M/ K/
N/ N/ N/ K/
P/ P/ N/ L/
P/ P/ P/ L/
P/ P/ P/ M/
P/ P/ R/ M/
R/ R/ R/ M/
R/ R/ S/ M/
R/ R/ T/ M1/
R/ R/ U/ M1/
S/ R/ U/ M2/
S/ T/ W/ N/
S/ T/ W/ N/ T
U/ U/ X/ O/
U/ U/ X/ O/ U
V/ U/ X/ O/
V/ U/ X/ O/ A
V/ U/ X/ O/ B
V/ U/ X/ O/ U
V/ U/ Y/ P/ C
V/ X/ Y/ P/ D
V/ X/ Y/ P/ E
W/ X/ Y/ P/ F
W/ X/ Y/ P/ F4945E
W/ Y/ Z/ Q/ F4945E
W/ Y/ Z/ Q/ F
W/ Y/ Z/ Q/ F(S)

Appendix 3: Equations for PB and PB2

PB

Determine the final ΔLead at EOT result by applying the correction factor calculated according to the following equations:

If $OC_{100\text{-}300} > 65.0$

$$\Delta Lead_{Final} = \exp[\ln(\Delta Lead) + (65.0 - OC_{100\text{-}300}) \times \mathbf{0.03234}]$$

If $OC_{100\text{-}300} \leq 65.0$

$$\Delta Lead_{Final} = \Delta Lead$$

Where:

ΔLead = final ΔLead at EOT

$OC_{100\text{-}300}$ = average oil consumption

PB2

Determine the final ΔLead (250 to 300) h by applying the correction factor calculated according to the following equations:

If $OC_{100\text{-}300} > 65.0$

$\Delta Lead\ (250\text{-}300)_{Final} = \exp[\ln(\Delta Lead(250\text{-}300)) + (65.0 - OC_{100\text{-}300}) \times \mathbf{0.04089}$

If $OC_{100\text{-}300} \leq 65.0$

$\Delta Lead\ (250\text{-}300)_{Final} = \Delta Lead(250\text{-}300)$

Where:

ΔLead (250-300) = final ΔLead (250 to 300) h

ΔLead (250-300) = value calculated per XXXX

$OC_{100\text{-}300}$ = average oil consumption

Data Source

- Dataset – LTMS 08/09/2023
  - Tests on Reference oil PC-10E/821 and re-blends
  - Exclusions:
    - Exclude tests with Chart = N (except W/ Y/ Z/ Q/ F)
    - Testkeys:
      - 98459, 98867 (goofy tests)
      - 109182 (thrown out in previous analyses)
      - 110864 (VUXPB)
  - Total number of tests: 135

General comments

- Latest batch of parts:
  - Cyl.Liner/TopRing/Rodbearing/MainBearing/PistonCrown[W/ Y/ Z/ Q/ F **randomized subgroups excluding subgroup A**]

- Original precision matrix
  - LTMS adopted use natural logarithm transformations for Pb, Pb2, and OC.

- The most recent review adopted LN transformation for CLW and TRWL